THE CLAIMS

What is claimed is:

1. A method of fabricating a microelectronic device structure including forming a ferroelectric or high ε film material by a growth process and depositing an electrode layer on a surface of the ferroelectric or high ε film material by a deposition process, wherein the growth process and the deposition process are carried out such that in the microelectronic device the ferroelectric or high ε film material at said surface and in the vicinity thereof is substantially stoichiometrically complete in oxygen concentration.

2. A method of fabricating a microelectronic device structure including depositing a top electrode layer on a ferroelectric or high ε film material by a deposition process including at least one of the following deposition process characteristics:

(1) the top electrode layer being formed of a metallic non-oxide material by sputtering in the presence of oxygen;

(2) the top electrode layer is formed of a noble metal that is formed by evaporation of a noble metal source material in the presence of oxygen;

(3) the top electrode layer is formed by sputtering under conditions minimizing bombarding energy and flux during deposition, whereby oxygen loss from the surface of the ferroelectric or high ε film material is minimized, and physical damage to the lattice of the ferroelectric or high ε film material is reduced;

(4) the ferroelectric or high ε film material surface is processed so that it contains excess oxygen, either in the lattice or in grain boundaries thereof, by ion implantation of oxygen at energies greater than 200 electron volts (eV);

(5) forming the top electrode layer from a noble metal by chemical vapor deposition (CVD), using a CVD process that incorporates oxygen; and

(6) deposition of a composite electrode film comprising a noble metal and an oxide compound.

3. The method of claim 2, wherein the top electrode is formed of a metallic non-oxide material by sputtering in the presence of oxygen.

4. The method of claim 3, wherein said presence of oxygen comprises conducting said sputtering in a sputtering environment including a gas selected from the group consisting of O_2, N_2O, NO_2, and mixtures of two or more thereof.

5. The method of claim 3, wherein said presence of oxygen comprises conducting said sputtering in a sputtering environment including O_2 gas.

6. The method of claim 3, wherein said sputtering is conducted under process conditions for deposition of a suboxide of a metal or a pure metal, despite the presence of oxygen in the sputtering environment.

7. The method of claim 6, wherein said process conditions are selected from at least one of the conditions of pressure, substrate temperature and deposition rate.

8. The method of claim 3, wherein the top electrode comprises a composite electrode including a first portion formed of said metallic non-oxide material by sputtering in the presence of oxygen, and a second portion formed of a second material in the absence of oxygen.

9. The method of claim 3, wherein the top electrode is formed of a material having a higher work function than the ferroelectric or high ε film material.

10. The method of claim 2, wherein the top electrode is formed of a sputtered pure metal, in the absence or non-incorporative presence of oxygen.

11. The method of claim 10, wherein the top electrode has a lower compressive stress than a corresponding top electrode sputtered in the presence of oxygen.

12. The method of claim 2, wherein the electrode is formed of a noble metal that is formed by evaporation of a noble metal source material in the presence of oxygen.

13. The method of claim 12, wherein the noble metal is selected from the group consisting of Pt, Pt oxides, Ir, Ir oxides, and compatible mixtures and alloys of two or more of the foregoing.

14. The method of claim 2, wherein the electrode layer is formed by sputtering under conditions minimizing bombarding energy and flux during deposition, whereby oxygen loss from the surface of the ferroelectric or high ε film material is minimized, and physical damage to the lattice of the ferroelectric or high ε film material is reduced.

15. The method of claim 2, wherein the ferroelectric or high ε film material surface is processed so that it contains excess oxygen, either in the lattice or in grain boundaries thereof, by ion implantation of oxygen at energies greater than 200 electron volts (eV).

16. The method of claim 15, wherein the ion implantation is conducted prior to depositing the top electrode.

17. The method of claim 15, wherein the ion implantation is conducted subsequent to depositing the top electrode.

18. The method of claim 2, wherein the top electrode layer is formed from a noble metal by chemical vapor deposition (CVD), using a CVD process that incorporates oxygen.

19. The method of claim 18, wherein the noble metal is selected from the group consisting of platinum, platinum oxides, iridium, iridium oxides, and compatible mixtures and alloys of two or more of the foregoing.

20. The method of claim 2, wherein deposition of the top electrode comprises depositing a composite electrode film comprising a noble metal and an oxide compound.

21. The method of claim 20, wherein the oxide compound yields oxygen content to the ferroelectric or high ε film material in contact with the composite electrode film.

22. The method of claim 21, wherein the oxide compound is selected from the group consisting of MnO, CeO_2, and mixtures and alloys thereof.

23. A method of fabricating a microelectronic device structure including depositing a top electrode layer on a lead zirconium titanate (PZT) film material by a process including at least one of the following deposition process characteristics:

(1) forming the PZT material by a deposition growth process including growth of the PZT material in an oxygen-containing environment, wherein said growth is carried out during a terminal part of the process under oxygen-excess conditions; and

(2) forming the PZT material by a deposition growth process including growth of the PZT material in an oxygen-containing environment, wherein said PZT material growth is carried out during a terminal part of the process under oxygen-deficient conditions producing a correspondingly oxygen-deficient metallic capping layer.

24. The method of claim 23, comprising forming the PZT material by a deposition growth process including growth of the PZT material in an oxygen-containing environment, wherein said growth is carried out during a terminal part of the process under oxygen-excess conditions.

25. The method of claim 24, wherein oxygen supply to the process is controlled during the process by selectively controlling at least one of oxygen partial pressure, oxygen absolute pressure and oxygen concentration, in said oxygen supply to the process.

26. The method of claim 24, wherein the excess-oxygen conditions are controlled so that the PZT film material in the vicinity of and at a top surface of the PZT film material will have an excess content of oxygen therein, above the stoichiometric level of oxygen required for $PbZrTiO_3$.

27. The method of claim 26, wherein said excess content of oxygen is substantially equivalent to the amount of oxygen abstracted from the PZT film material in the step of depositing a top electrode layer on the PZT film material.

28. The method of claim 23, wherein the PZT material is formed by a deposition growth process including growth of the PZT material in an oxygen-containing environment, wherein said PZT material growth is carried out during a terminal part of the process under oxygen-deficient conditions producing a correspondingly oxygen-deficient metallic capping layer, whereby said metallic capping layer reduces oxygen mobility/depletion in the PZT film material depositing a top electrode layer on the PZT film material.

29. The method of claim 28, wherein said metallic capping layer is etched prior to the step of depositing a top electrode layer on the PZT film material, under conditions restricting surface depletion of oxygen, thereby exposing a surface of the PZT film material for the step of depositing the top electrode layer on the PZT film material.

30. The method of claim 1, wherein said ferroelectric or high ε film comprises an oxide perovskite or layered structure perovskite.

31. The method of claim 1, wherein said ferroelectric or high ε film comprises a material selected from the group consisting of lead zirconium titanate, barium and/or strontium titanates, and strontium bismuth tantalates.

32. The method of claim 1, wherein said ferroelectric or high ε film comprises a lead zirconium titanate material.

33. The method of claim 1, wherein said ferroelectric or high ε film comprises a barium and/or strontium titanate material.

34. The method of claim 1, wherein said ferroelectric or high ε film comprises a strontium bismuth tantalate material.

35. The method of claim 1, wherein said top electrode layer comprises a material selected from Pt, Pt oxides, Ir, Ir oxides, and compatible mixtures and alloys of the foregoing.

36. The method of claim 1, wherein said top electrode layer comprises a Pt material.

37. The method of claim 1, wherein said top electrode layer comprises a Pt oxide material.

38. The method of claim 1, wherein said top electrode layer comprises an Ir material.

39. The method of claim 1, wherein said top electrode layer comprises an Ir oxide material.

40. A microelectronic device structure including a top electrode layer on a ferroelectric or high ε film material, wherein the ferroelectric or high ε film material at said surface and in the vicinity thereof is substantially stoichiometrically complete in oxygen concentration.

41. A microelectronic device structure according to claim 40, wherein said ferroelectric or high ε film comprises an oxide perovskite or layered structure perovskite.

42. A microelectronic device structure according to claim 40, wherein said ferroelectric or high ε film comprises a material selected from the group consisting of lead zirconium titanate, barium and/or strontium titanates, and strontium bismuth tantalates.

43. A microelectronic device structure according to claim 40, wherein said ferroelectric or high ε film comprises a lead zirconium titanate material.

44. A microelectronic device structure according to claim 40, wherein said ferroelectric or high ε film comprises a barium and/or strontium titanate material.

45. A microelectronic device structure according to claim 40, wherein said ferroelectric or high ε film comprises a strontium bismuth tantalate material.

46. A microelectronic device structure according to claim 40, wherein said top electrode layer comprises a material selected from Pt, Pt oxides, Ir, Ir oxides, Pd, Pd oxides, Rh, Rh oxides, and compatible mixtures and alloys of the foregoing.

47. A microelectronic device structure according to claim 40, wherein said top electrode layer comprises a Pt material.

48. A microelectronic device structure according to claim 40, wherein said top electrode layer comprises a Pt oxide material.

49. A microelectronic device structure according to claim 40, wherein said top electrode layer comprises an Ir material.

50. A microelectronic device structure according to claim 40, wherein said top electrode layer comprises an Ir oxide material.